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(54) **Process for planting of woody stem plants by hydroboring**

(57) A process for planting of woody stem plants by hydroboring, wherein a planting hole is prepared by means of a hydroboring apparatus, slow- and/or quick-acting fertilizer composition containing up to 75% of wt. of N, P_2O_5 and K_2O macro nutritive elements and up to 10% wt. of Mg, Cu, Mn, Zn, Fe and B micro nutritive elements in desired ratio are admixed with the boring water and the reproducer is placed into the planting hole. The boring water may optionally contain fine-crushed organic and/or inorganic substance, soil-desinfectants and/or fungicides or different compounds controlling the plants' processes, e.g. compounds with hormonic activity or their precursors. For the plantation rooted or rootless reproducers can be used. According to the process of the invention different woody stem plants e.g. poplars, willows, vines, peaches etc. can successfully be planted.

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SPECIFICATION

Process for planting of woody stem plants

The present invention relates to a process for planting of woody stem plants by hydroboring, wherein the planting hole is prepared by a hydroboring apparatus and plant nutrients, different compounds and compositions controlling the plant's vital processes or plant protecting agents as well as substances for amelioration admixed with the boring water are applied to the soil.

Into the hole thus prepared rooted or rootless propagation materials /reproducers/ are placed. According to the process of the invention different woody stem plants e.g. poplar, wilow, vine, peach and other types of fruits can successfully be planted by large-scale industrial methods into any type of soils except stony soils.

Background of the invention

It is well known that planting of forests and fruit-gardens is carried out by two methods. One of these methods is the traditional process wherein a hole is dug of the size of 60×60×60 cm, the reproducer is placed into the hole, the soil dug out is replaced around the reproducer, it is watered and finally the soil is compacted. The other method is the mechanical deep drilling method, wherein the planting hole is prepared by means of a twist deep borer which lifts out the loosened soil from the hole and places it beside it. Into the hole thus obtained organic fertilizer and/or fertilizer are added, the reproducer is placed into it, the soil is compacted by replacing same around the reproducer and the young sapling is watered.

It is a drawback of the traditional process that it is extraordinarily labour-consuming and consequently expensive and slow. The drawback of the mechanical deep driling method consisting of several work-phases is that the twist drill compacts the sides of the hole, thus subsequent to the placing of the reproducer into the hole the soil has to be broken up and has to be compacted around the sapling. An additional drawback is the intensive wear of the bit edge and consequently the frequent and expensive change of the bit. A further drawback is in case of both known processes the low ratio of plants taking root and the annual low yield of crops.

In order to eliminate the drawbacks of the known methods mentioned above we have investigated the possibilities of the development of a new technology and we have made a series of experiments on different types of soils and under different weather conditions employing different types of reproducers. In case of predominantly bad, sandy soils assigned for forest plantation which soils are unsuited for field and horticultural husbandary due to the low water table and the insufficient nutrient supply, we have found that the nutritive element content of the leaves of 3-5 m tall poplar cuttings with crown buds – planted in a depth of 2-4 m – does not reach the optimal values regarding certain elements. The reason for this is that by carrying out the planting up to the water table the water supply of the plant becomes more favourable, the plant grows more quickly but the soil does not contain sufficient nutrients to ensure the optimum nutrient level. The test data of a 2 year old poplar plantation are given in Table 1. The test data relate to plants planted by traditional technology as well as by the process of the invention and both are compared with the optimum values. The data relate to leaf-dry substance.

TABLE 1

Nutritive element content		*Optimum value*	*Planting with traditional process*	*Planting with hydroboring process*
Nitrogen	% by wt	2.50	2.50	2.30
Phosphorus	% by wt	0.25	0.24	0.19
Potassium	% by wt	1.50	1.50	1.27
Calcium	% by wt	1.70	1.80	2.00
Magnesium	% by wt	0.40	0.37	0.39
Iron	ppm	200	130	105
Manganese	ppm	120	125	95
Zinc	ppm	60	44	20
Copper	ppm	15	11	8
Boron	ppm	60	59	51
Molybdenum	ppm	0.5	0.8	1.0

Different researchers described similar results but in the course of their investigations the intensive growth of the plants was not due to the optional amount of used water but the great amount of nitrogen-fertilizer /Vagoor, Lehrbuch der Pflanzenphysiologie, VEB Gustav Verlag Jena 1979. pp. 137-138; and Souchelli: Trace-elements in agriculture, Von Nostran Beinhald Co., New York 1969. pp. 201-209/.

into account all parameters having importance from point of view of the dynamic unity of plant and its environment and which technology produces harmony between the plant protection and nutriation adjusted to the plant's vital processes during the whole vegetation period particularly during the growing period just after taking root. The planting process by hydroboring according to the invention is the result of our wide-spread experimental work and it offers a great help in the large scale industrial planting of forest and fruit garden.

Detailed description of the invention

According to the process of the invention for planting of woody stem plants a planting hole is prepared by hydroboring apparatus of a deepness of 2-4 m depending on soil quality and type of plant to be planted. Previously slow- or quick-acting fertilizer compositios containing the necessary nutrients are dispersed in the boring water. These compositions contain up to 75 % by weight of N, P_2O_5 and K_2O as macro-nutritive elements and up to 10 % by weight of Mg, Cu, Mn, Zn, Fe and B as micro-nutritive elements in the desired ratio.

The boring water may optionally contain fine-crushed organic substances e.g. organic fertilizer and/or turf to increase the nutrient content and for amelioration, it may also contain fine-crushed inorganic substances e.g. zeolite, pearlite or other types of mineral clays. If desired soil- desinfectants, preferably phosphorus acid-, thiophosphorous acid- or dithiophosphorous acid-ester-derivatives, e.g. O-ethyl-S-phenyl-ethyl-phosphonodithioate /DYFONATE/, 2-chloro-3-/-diethylamino/-1-methyl-3-oxo-1-propanyl-dimethyl-phosphate /DIMECRON/ O,O-diethyl-O-/2-isopropyl-6-methyl-4-pyrimidinyl/-phosphorothioate /DIAZINON/, S-/2,5-dichlorophenylthiomethyl/-O,O-diethyl-phosphorodithioate /PHENKAPTON/, etc. may also be mixed into the boring water.

As fungicides triphenyl-stannic acetate /BRESTAN/ and/or zinc- or manganese dithiocarbamate derivatives /MANEB, MANCOZEB, ZINEB/, etc. can preferably be mixed into the boring water.

For controlling the plant's vital processes, if desired different compounds having hormonic activity /e.g. gibberellinic acid or its derivatives, auxin or cytoquinine or cytoquinine-like substances/, or compounds being transformed into such compounds in the plant /e.g. precursors, methionin/ may also be added to the boring water.

The rooted or rootless reproducers are placed into the planting hole prepared by using boring water of 3-4 bar pressure containing all the necessary substances mentioned above.

The advantage of the process according to the invention compared with the known methods is that it can be carried out quickly and economically since the preparation of the planting hole, the addition of nutrients, water and other substances /plant protectives, soil-ameliorating materials, regulators etc./, the compacting of the soil around the plant are made in a single step by using mechanical power and the demand of physical work is reduced to one third. A further advantage of the process of the invention is that the water in the bored hole produces a sludge-bed which surrounds the sapling and fixes it without any specific compacting operation. The sluge-bed contains every material in desired quality and quantity necessary to the sufficient taking roots and growing of the plant and surrounds the underground part of the plant in a fairly large volume and in uniform distribution thus solving the constant and uniform nutrient-supply harmonizing with the vital processes in the long run. Despite of the relative high nutrient concentration considerable amount of fertilizer can be economized since there is no need for the so called "reserve fertilization" of the whole plantation area and the effective nutrient supply can be solved with the one fifth part of the earlier amount.

Further advantage of the process of the invention is that the local amelioration of soil of bad quality can simply be realized simultaneously with the planting. The most important advantage of the process is that the planting of forests and fruit-gardens can be carried out under such conditions under which it was impossible or complicated when using the known methods. As an advantage the fact can finally be mentioned that, the healthy, rapidly growing plant stock can earlier achieve the state, when it can be utilized, e.g. in case of poplar the felling rotation /in average 25 years/ is reduced at least to one half.

The invention is illustrated by the following, non-limiting examples.

Example 1

Comparative test of poplar plantations planted by mechancial deep-boring and by hydroboring

On an area of 1 ha of weakly humic soil poplars are planted in 4 repetitions at a square-distance of 5×3 m from one another by mechanical deep-boring and by hydroboring using rootless reproducers. The comparative test of the plantations was carried out 2 years after the planting. The average results are

summarized in Table 2.

TABLE 2

	Taking roots /%/	Stem-diameter /cm/	Height of trees /m/	Production of organic substances /%/
Mechanical deep-boring	81	2.66	1.90	100
Hydroboring	94	2.76	2.02	114

Example 2
Comparative test of poplar plantations planted by hydroboring and hydroboring + addition of plant nutrients

On an area of 1 ha of weakly humic soil poplars are planted in 4 repetitions at a square-distance of 5×3 m from one another by hydroboring and hydroboring + addition of plant nutrients, using rootless reproducers. At the time of the planting soil-examinations were carried out, the results thereof are summarized in Table 3. The plant nutrients were added in two different doses /250 g/tree and 500 g/tree/. The different components of the nutrients as well as the water-solubility and the nutritive-element content thereof are summarized in Table 4. The examination of the plantations has been carried out for 4 years starting from the planting. The average test results in every year are summarized in Table 5. The nutritive element content of the leaves was determined two years after the planting, the results thereof are summarized in Table 6.

TABLE 3

Tested parameters		*Values*
pH		7.5
Heaviness		30
$CaCO_3$	% by wt	5.0
Humus	% by wt	0.88
$NO_2 + NO_3$	ppm	1.6
P_2O_5	ppm	101
K_2O	ppm	112
Mg	ppm	56
Na	ppm	39
Zn	ppm	5.2
Cu	ppm	5.7
Mn	ppm	16.1
SO_4^{2-}	ppm	5.1

TABLE 4

Components of the fertilizer	*Solubility at 20°C % by wt*	*Nutritive elements*	*Nutritive element content in the fertilizer % by wt*
Urea-formaldehide cond.	$10^{-2}-10^{-1}$	Nitrogen	20
		P_2O_5	11
Potassium chloride	good	K_2O	14
Potassium magnesium phosphate	$10^{-2}-10^{-1}$	Mg	4
Culpric ammonium phosphate	$10^{-3}-10^{-2}$	Cu	0.4
Manganese ammonium phosphate	$10^{-3}-10^{-2}$	Mn	0.2
Zinc ammonium phosphate	$10^{-3}-10^{-2}$	Zn	0.1
Iron ammonium phosphate	$10^{-3}-10^{-2}$	Fe	0.35
Boric acide	good	B	0.05

TABLE 5

Time after the planting	*Nutrient dose g/tree*	*Stem diameter /cm/*	*Height of trees /cm/*	*Production of organic substances /%/*
1 year	0 /control/	1.06	99.8	100
	250	1.10	95.9	105
	500	1.24	95.8	110
2 years	0 /control/	2.72	202.8	100
	250	2.88	213.1	118
	500	2.97	219.4	129
3 years	0 /control/	5.35	351.0	100
	250	5.75	375.0	123
	500	5.99	379.0	130
4 years	0 /control/	9.26	543.0	100
	250	10.57	592.0	142
	500	10.89	595.0	152

TABLE 6

Nutritive elements	Nutritive element content in the dry leaves 0 g/tree	250 g/tree	500 g/tree
Nitrogen	2.79 % by wt	3.00 % by wt	2.79 % by wt
Phosphorous	0.19 % by wt	0.19 % by wt	0.19 % by wt
Potassium	1.57 % by wt	1.64 % by wt	1.62 % by wt
Ca	2.21 % by wt	2.11 % by wt	2.10 % by wt
Mg	0.39 % by wt	0.40 % by wt	0.44 % by wt
Fe	94.7 ppm	96.7 ppm	107.5 ppm
Mn	95.0 ppm	89.0 ppm	91.7 ppm
Zn	19.5 ppm	21.9 ppm	23.5 ppm
Cu	7.8 ppm	9.8 ppm	9.0 ppm
B	51.0 ppm	56.0 ppm	62.0 ppm

Example 3

Examination of insecticidal and fungicidal activity on poplar plantations planted by hydroboring

According to Example 2 poplars are planted on humic soil. At the time of the planting soil test was carried out and the degree of infection by insects and fungis was determined. The area was infected by Anoxia pilosa and Cytospora chrysosperma. The pesticide contains O-ethyl-S-phenylethyl-phosphorodithioate /DYFONATE/ as active ingredient /applied dose: 30 g active ingredient/ tree/, the fungicide contains triphenyl stannic acetate /BRESTAN/ as active ingredient /applied dose: 1.5 g active ingredient/tree/. A third experiment was carried out by mixing a fertilizer composition according to Example 2 into the boring water together with the insecticide and fungicide.

The results of the soil tests carried out at the same time on the planting are given in Table 7, the test results

obtained one year after the planting are summarized in Table 8.

TABLE 7

Tested parameters		*Values*
pH		7.5
Heaviness		32
$CaCO_3$ % by wt		6.4
Humus % by wt		1.47
$NO_2 + NO_3$ ppm		2.3
P_2O_5	ppm	110
K_2O	ppm	150
Mg	ppm	39
Na	ppm	18
Zn	ppm	5.6
Cu	ppm	3.2
Mn	ppm	8.6
SO_4^{2-}	ppm	7.8

TABLE 8

Treatment	*Infection by Anoxia pilosa /%/*					*Infection by Cytospora chrysosperma*				
	1	*2*	*3*	*4*	*Average*	*1*	*2*	*3*	*4*	*Average*
Dyfonate + Brestan	1	0	0	0	0.25	0	0	0	0	0
Dyfonate + Brestan + Fertilizer	0	1	0	0	0.25	0	0	0	0	0
Control	3	7	6	1	4.25	10	9	4	6	7.25

Example 4

Effect of fine-crushed inorganic substance addition /manganese mud from Urkut/ on poplar planted by hydroboring

Poplars are planted on weakly humic soil according to Example 2. At the time of the planting soil test was carried out the results of which are summarized in Table 9. In order to examine the effect of manganese mud it was added in an amount of 500 g/tree. In the course of another experiment the activity of the fertilizer composition according to Example 2 /in an amount of 125 g/tree / together with the manganese mud was

examined. The experiments were evaluated one year after the planting. The results are summarized in Table 10.

TABLE 9

Tested parameters		*Values*
pH		7.6
Heaviness		30
$CaCO_3$ % by wt		4.2
Humus % by wt		0.9
$NO_2 + NO_3$ ppm		1.4
P_2O_5	ppm	78
K_2O	ppm	86
Mg	ppm	55
Na	ppm	36
Zn	ppm	5.8
Cu	ppm	1.2
Mn	ppm	10.5
SO_4^{2-}	ppm	5.0

TABLE 10

Treatment	Stem diameter /mm/				Average	Height of trees /cm/				Average	Production of organic substance /%/
	1	2	3	4		1	2	3	4		
Manganese mud	9.9	10.3	10.2	10.4	10.15	97	98	97	98	97.5	106.3
Manganese mud + fertilizer	10.3	10.8	10.9	10.6	10.65	99	97	98	99	98.25	114.4
Control	9.2	9.7	9.6	9.6	9.5	102	95	96	99	98	100

TABLE 11

Treatment	Stem diameter /mm/				Average	Height of trees /cm/				Average	Production of organic substance /%/
	1	2	3	4		1	2	3	4		
Organic fertilizer	9.6	9.6	9.5	9.5	9.55	100	99	101	100	100	103
Organic fertilier + fertilizer	10.8	10.3	10.6	10.6	10.6	102	98	99	100	99.75	111.4
Control	9.2	9.7	9.6	9.6	9.5	102	95	96	99	98	100

Example 5

Effect of fine crushed organic substance addition /organic fertilizer/ on plantation of poplars planted by hydroboring

The experiment was carried out according to Example 4 but organic fertilizer in an amount of 3 liter/tree was used instead of manganese mud, admixed with the boring water. The experiment was evaluated one year after the plantation, the results are summarized in Table 11.

Example 6

Effect of addition of compounds with hormonic activity on poplar plantations planted by hydroboring

The experiment was carried out according to Example 4, but a compound with hormone active agent /gibberellin/ in an amount of 0.05 g/tree instead of manganese mud was used and mixed into the boring water.

The experiment was evaluated one year after the planting, the results thereof are summarized in Table 12.

TABLE 12

Treatment	Stem diameter /mm/ 1	2	3	4	Average	Height of trees /cm/ 1	2	3	4	Average	Production of organic substance /%/
Gibberellin	9.3	9.5	9.6	9.6	9.5	103	101	103	102	102.25	104.3
Gibberellin + fertilizer	10.6	10.8	10.6	10.7	10.6	101	99	99	100	99.75	113.6
Control	9.2	9.7	9.6	9.6	9.5	102	95	96	99	98	100

TABLE 13

Treatment	Taking roots /%/	Shoot-diameter /mm/	Shoot-length /mm/	Weight of leaves g/stock	Production of organic substance /%/
20 g/stock fertilizer	96	5.13	733	81.73	115.7
40 g/stock fertilizer	95	5.19	771	85.39	127.1
Control	94	4.92	683	66.28	100

Example 7
Comparative test of vine-plantations planted by hydroboring and by hydroboring + addition of plant nutrients

Vine is planted on humic sandy soil by mixing a fertilizer composition into the boring water in an amount of 20 and 40 g/vine-stock, respectively. The experiment was evaluated one year after the planting. the average values of 200-200 vine-stocks are summarized in Table 13.

Example 8
Comparative test of peach plantations planted by hydroboring and by hydroboring + addition of plant nutrients

Peach trees are planted on middle-hard adobe-soil 100 cm deep by mixing a fertilizer composition according to Table 4 into the boring water in an amount of 40 g/tree and 80 g/tree, respectively. The experiment was evaluated one year after the planting, the results are summarized in Table 14.

TABLE 14

Treatment	*Taking roots /%/*	*Stem diameter /mm/*	*Production of organic substances /%/*
40 g/tree fertilizer	83	35.7	116
80 g/tree fertilizer	87	38.9	126
Control	64	30.8	100

CLAIMS

1. Process for planting of woody stem plants by hydroboring, which comprises placing into the planting hole prepared by hydroboring apparatus, plant nutrients, optionally fine-crushed organic and/or inorganic substances, soil disinfectant and/or fungicides and/or compounds of hormone activity or precursors thereof admixed with the boring water and placing the reproducers into the planting hole.
2. Process as claimed in claim 1, which comprises using fertilizer compositions as plant nutrients containing up to 75 % by wt of N, P_2O_5 and K_2O macro-nutritive elements and up to 10 % by wt of Mg, Cu, Mn, Zn, Fe and B micro-nutritive elements in desired ratio.
3. Process as claimed in claims 1 to 2, which comprises using the plant nutritive elements in form of slow- and/or quick-acting fertilizer compositions.
4. Process as claimed in claim 1, which comprises using organic fertilizers and/or turf as fine-crushed organic fertilizers.
5. Process as claimed in claim 1, which comprises using zeolite, pearlite or other types of mineral clays as fine-crushed inorganic substances.
6. Process as claimed in claim 1, which comprises using phosphoric acid-, thiophosphoric acid-ester-derivatives as soil desinfectants.
7. Process as claimed in claim 1, which comprises using triphenyl stannic acetate and/or zinc- and/or manganese-dithiocarbamates as fungicides.
8. Process as claimed in claim 1, which comprises using gibberellinic acid or gibberellinic acid-derivatives, auxin or cytoquinine or cytoquinine-like compounds as compounds of hormone activity.
9. Process as claimed in claim 1, which comprises using amino acids as compounds being transformed into compounds with hormone activity in the plant.
10. Process as claimed in any of claims 1 to 9, which comprises placing rooted or rootless reproducer into the planting hole.
11. A process as claimed in claim 1 and substantially as hereinbefore described in any one of Examples 1 to 8.

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